

WATER AUDITS AND LOSS CONTROL PROGRAMS

USING THE M36 TO
IMPROVE THE WATER
AUDIT

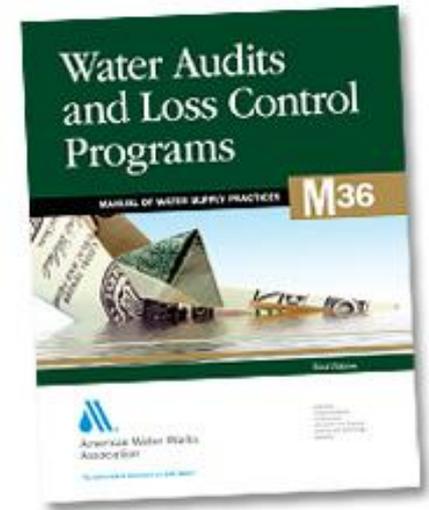
BY: ANDREW CHASTAIN-HOWLEY



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M36 3RD EDITION WATER AUDITS AND LOSS CONTROL PROGRAMS

- Chapter 1 – Introduction: Auditing Water Supply Operations and Controlling Losses
- Chapter 2 – Conducting the Water Audit
- Chapter 3 – Identifying and Controlling Apparent Losses
- Chapter 4 – Understanding Real Losses: The Occurrence and Impacts of Leakage
- Chapter 5 – Controlling Real Losses: Leakage and Pressure Management
- Chapter 6 – Planning and Sustaining the Water Loss Control Program
- Chapter 7 – Considerations for Small Systems



History: AWWA Water Audit Methodology

- Method published in 2000 by IWA Water Loss Task Force with AWWA participation
- All water goes to either consumption or loss - with definitions for all uses and water losses
- Designed to function for all units of measure
- Includes performance indicators for realistic assessments, benchmarking, and target-setting
- AWWA WLCC recommended IWA Water Balance and Performance Indicators in 2003



Opflow Online

Volume 32, No. 5 May 2006

Unaccounted for No More Water Audit Software Assesses Water Loss

By George Kunkel

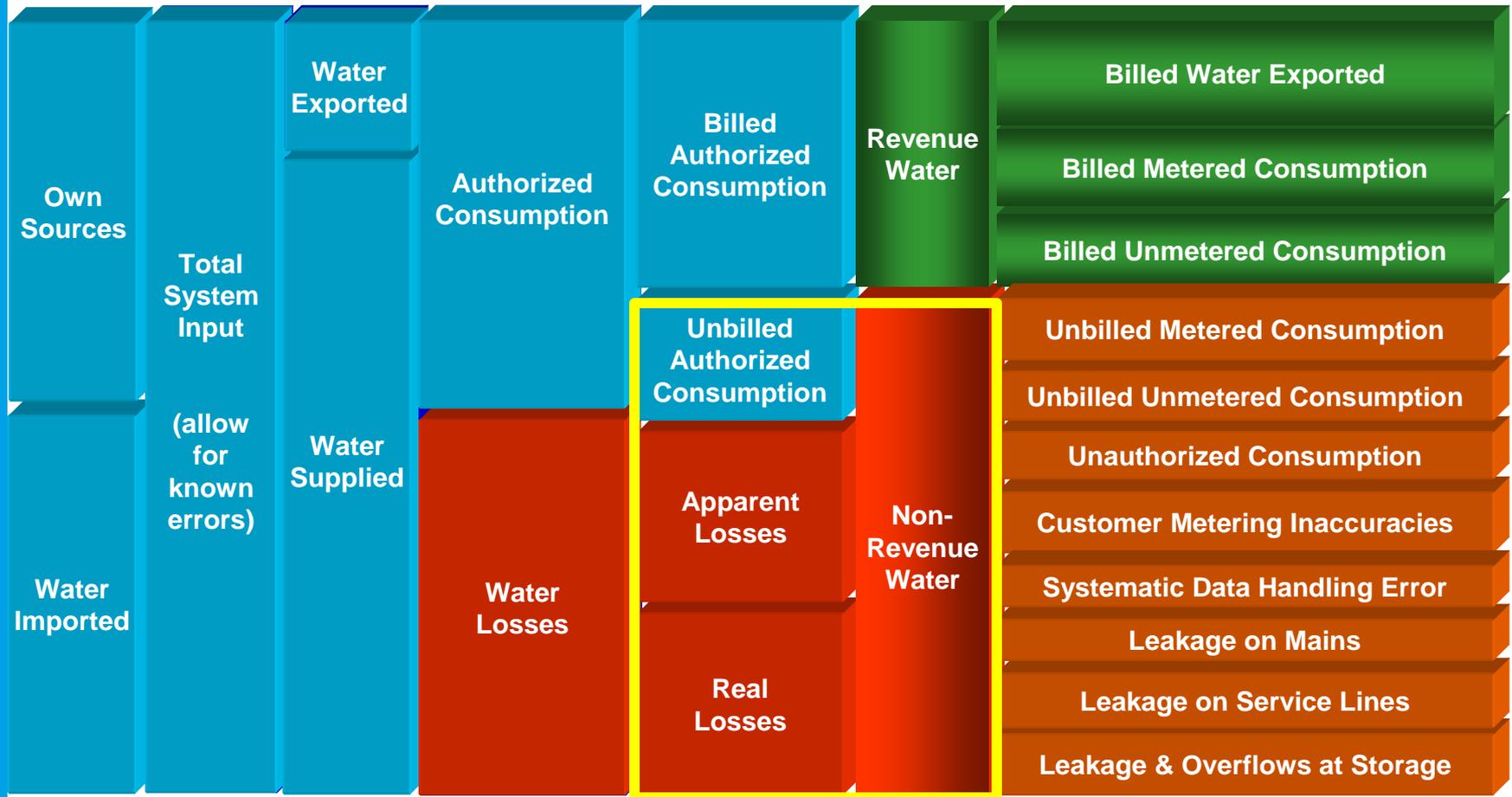
Water utilities now have a standardized tool to determine water supply efficiency: a spreadsheet software package for compiling a basic audit of water supply operations, developed by AWWA's Water Loss Control Committee. The software is available to anyone for free download.

The software was developed to

- promote the best-practice water audit method developed by the International Water Association and AWWA,
- assess water supply efficiency in a standard, reliable manner, and
- give utilities a simple, user-friendly way to compile and compare their water audit data with other utilities.



WATER AUDIT STANDARD FORMAT



CHAPTER REVIEW

CHAPTER 2

CONDUCTING THE WATER AUDIT

The M36 has always provided outstanding guidance in the details of auditing

- **Water Supplied: source meter data, imports/exports**
- **Master Meter Error Adjustment**
- **Authorized Consumption**
 - **Billed Metered**
 - **Billed Unmetered**
 - **Unbilled Metered**
 - **Unbilled Unmetered**



CHAPTER 2

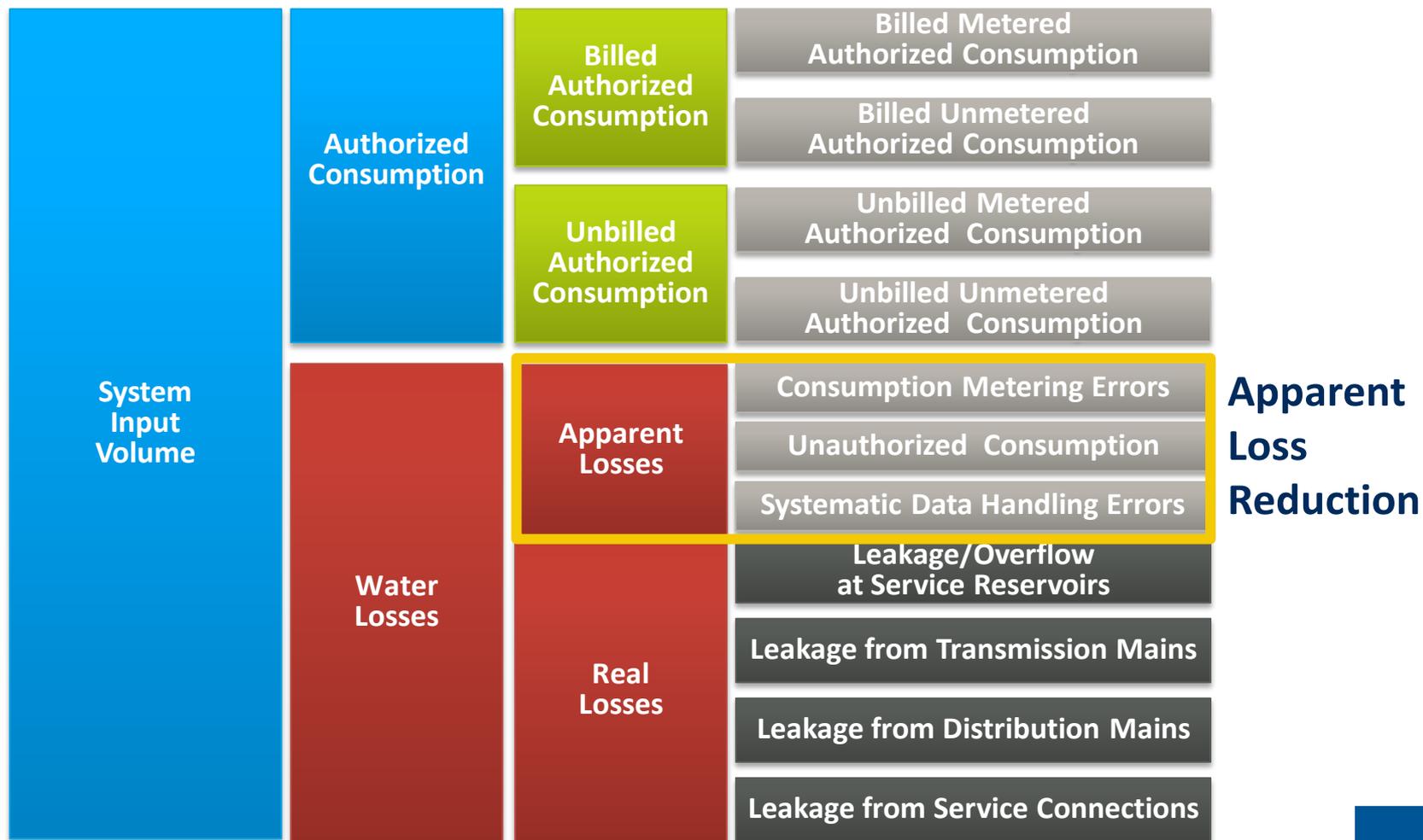
TOP-DOWN APPARENT LOSS WATER AUDIT DATA

Apparent Losses: systematic data handling error

- Category of apparent loss was identified by AWWA WLC Committee
 - Includes all forms of data transfer, handling and archiving error in billing
 - Manual meter reading
 - Automatic meter reading
 - Billing system errors
- The “dark horse” of loss auditing
- The suggested starting point is assessing apparent losses – *find out what goes on in the billing system!*

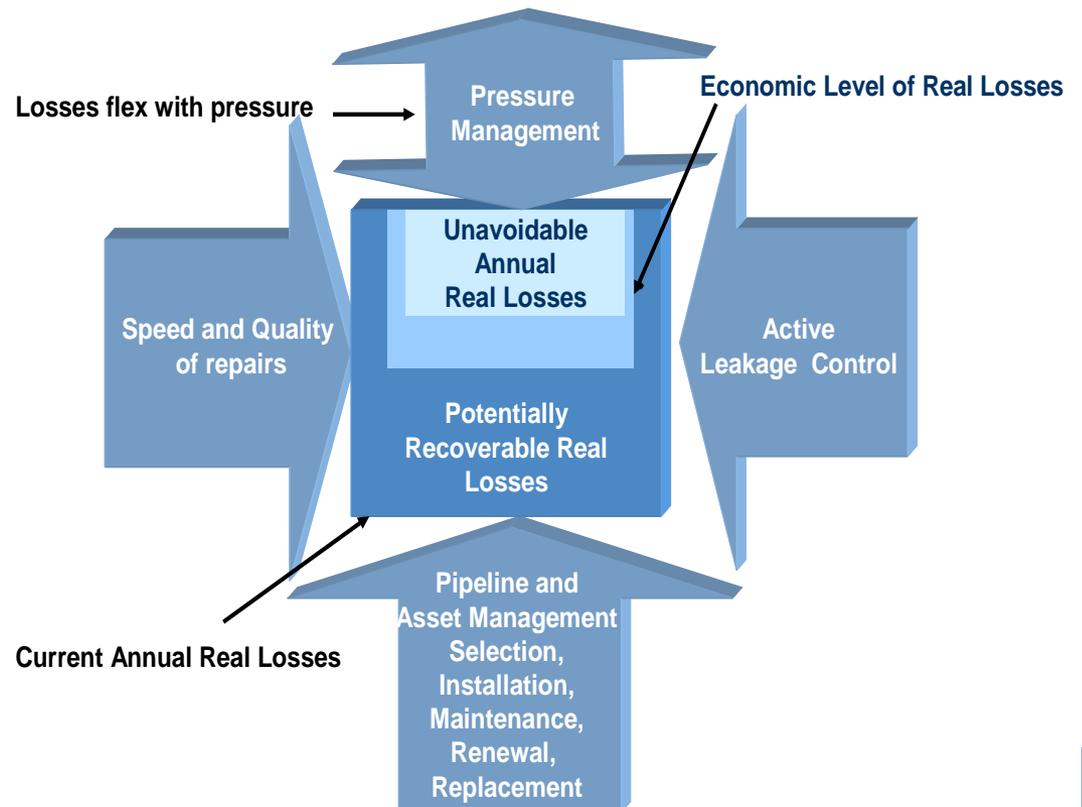


APPARENT LOSS IN THE AWWA WATER BALANCE



CHAPTER 4 UNDERSTANDING REAL LOSSES. THE OCCURRENCE AND IMPACT OF LEAKAGE

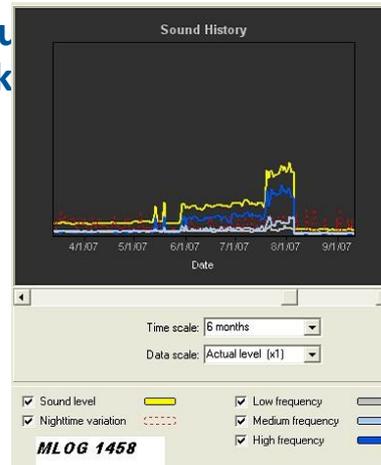
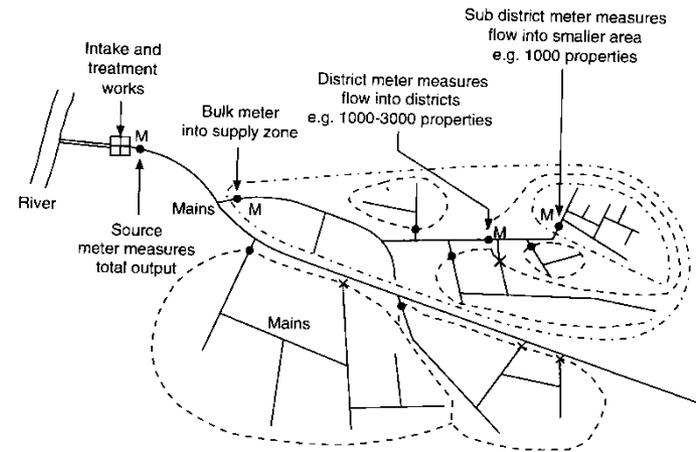
- Chapter 4 – Leakage Characteristics
 - Types of leakage
 - Effect of time on leakage losses



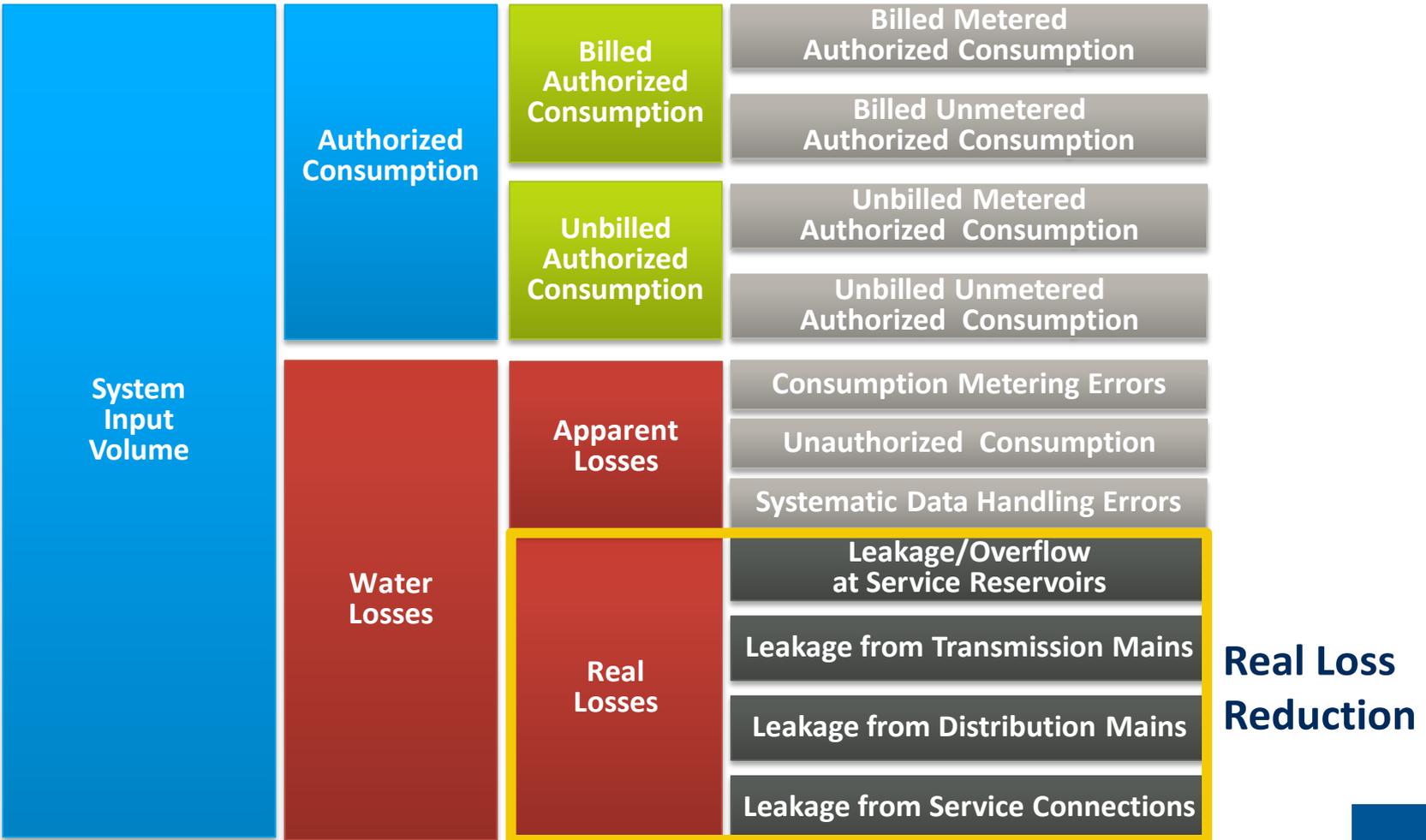
CHAPTER 5

CONTROLLING REAL LOSSES: LEAKAGE AND PRESSURE MANAGEMENT

- **Active Leakage Control**
 - Traditional leak detection
 - Leak noise monitoring
 - Continuous flow/pressure monitoring in discrete zones or DMAs
- **Pressure Management**
 - Pressure stabilization
 - Pressure reduction
 - Very cost-effective and successful addressing high background leak



REAL LOSS IN THE AWWA WATER BALANCE



CHAPTER 6

PLANNING & SUSTAINING THE WATER LOSS CONTROL PROGRAM

Forming the multidisciplinary team

- Water Distribution System Operations
- Water Distribution System Maintenance
- Customer Metering
- Customer Meter Reading
- Infrastructure Management
- Water Quality
- Sewer Collection Systems
- Water Conservation
- Customer Billing Systems
- Water Rate Setting and Finance
- Customer Affairs
- Public Relations
- External stakeholders: regulatory, other
- Executive leadership of the water utility



CHAPTER 7

CONSIDERATION FOR SMALL SYSTEMS

- 54,000 water utilities serve fewer than 10,000 people
- AWWA Free Water Audit Software: designed (and priced) with small systems in mind
- Assistance available through water industry associations such National Rural Water Association and AWWA
- Authorization of funding sources to handle water loss control efforts
- Use of performance-based consulting services contracts

AWWA WLCC Water Audit Software: Reporting Worksheet
Copyright © 2005, American Water Works Association. All Rights Reserved. [Back to Instructions](#)

Water Audit Report for **Philadelphia Water Department**
Reporting Year: **2004**

Please enter data in the white cells below. Where possible, metered values should be used; if metered values are unavailable please estimate a value. Indicate this by selecting a choice from the gray box to the left, where M = measured (or accurately known value) and E = estimated.

ALL VOLUMES TO BE ENTERED AS ANNUAL QUANTITIES

WATER SUPPLIED	
Volume from own sources:	M 95,226.0 million gallons (MG) per year
Master meter error adjustment:	M 692.4 million gallons (MG) per year
Water Imported:	M 2.0 million gallons (MG) per year
Water Exported:	M 7,210.2 million gallons (MG) per year
WATER SUPPLIED:	88,015.2 million gallons (MG) per year

AUTHORIZED CONSUMPTION	
Billed metered:	M 57,535.2 million gallons (MG) per year
Billed unmetered:	M 0.0 million gallons (MG) per year
Unbilled metered:	M 175.2 million gallons (MG) per year
Unbilled unmetered:	E 693.6 million gallons (MG) per year
AUTHORIZED CONSUMPTION:	58,404.0 million gallons (MG) per year

WATER LOSSES (Water Supplied - Authorized Consumption)	
Apparent Losses	30,603.1 million gallons (MG) per year
Unauthorized consumption:	E 1,145.2 million gallons (MG) per year
Customer metering inaccuracies:	E 125.2 million gallons (MG) per year
Data handling errors:	E 2,751.2 million gallons (MG) per year
Apparent Losses:	4,058.8 million gallons (MG) per year
Real Losses	26,544.2 million gallons (MG) per year
Real Losses (Water Losses - Apparent Losses):	26,544.2 million gallons (MG) per year
WATER LOSSES:	30,603.1 million gallons (MG) per year

NON-REVENUE WATER	
NON-REVENUE WATER:	31,476.0 million gallons (MG) per year

SYSTEM DATA	
Length of mains:	M 3,160.0 miles
Number of active AND inactive service connections:	M 548,289
Connection density:	E 174 conn./mile main
Average length of private pipe:	E 12.0 ft (pipe length between curbstop and customer meter or property)
Average operating pressure:	E 55.0 psi

COST DATA	
Total annual cost of operating water system:	M \$167,604,000 \$/year
Customer retail unit cost (applied to apparent losses):	M \$2.90 \$/1,000 gallons (G)
Variable production cost (applied to real losses):	M \$133.25 \$/million gallons (MG)

DATA REVIEW - Please review the following information and make changes above if necessary:

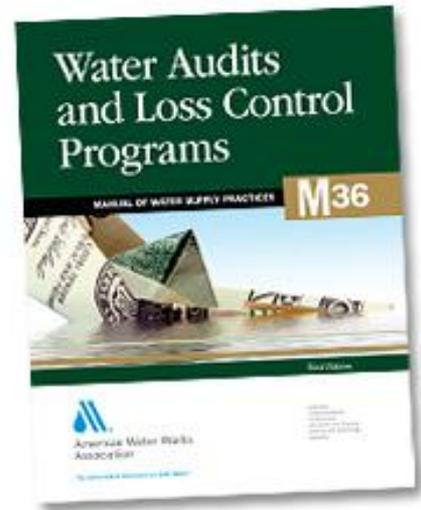
- Input values should be indicated as either measured or estimated. You have entered:
 - 12 as measured values
 - 6 as estimated values
 - 0 without specifying measured or estimated
- It is important to accurately measure the master meter - you have entered the measurement type as: measured
- Cost Data: No problems identified

PERFORMANCE INDICATORS	
Financial Indicators	
Non-revenue water as percent by volume:	35.41
Non-revenue water as percent by cost:	11.74
Annual cost of Apparent Losses:	\$16,012,518
Annual cost of Real Losses:	\$3,545,766
Operational Efficiency Indicators	
Apparent losses per service connection per day:	20.28 gallons/connection/day
Real losses per service connection per day:	132.64 gallons/connection/day
Real losses per length of main per day:	N/A
Real losses per service connection per day per psi pressure:	2.41 gallons/connection/day/psi
Unavoidable Annual Real Losses (UARL):	5.98 million gallons/day
Infrastructure Leakage Index (ILI) [Real Losses/UARL]:	12.17

* only the most applicable of these two indicators will be calculated

SUMMARY – M36 3RD EDITION

- *Details and Promotes the IWA/AWWA Water Audit Method*
- *Describes cost-effective ways to control apparent and real losses*
- *Gives Planning Guidance and Support Information – link to Free Water Audit Software*
- *The methods and tools exist to control water and revenue losses.*



Send your comments & questions to:

wlc@awwa.org

Or

chastain-howleya@bv.com

Audits Required w/ Performance Targets

(AWWA Methodology)

10% Leakage,
3 year average

10% Leakage

10%
UFW

25% WL (small)
15% (large)

15% WL

10% UFW

25% WL

MA
15% NAW

DRBC

RI
15% NAW

NJ
Median UFW %
of Class

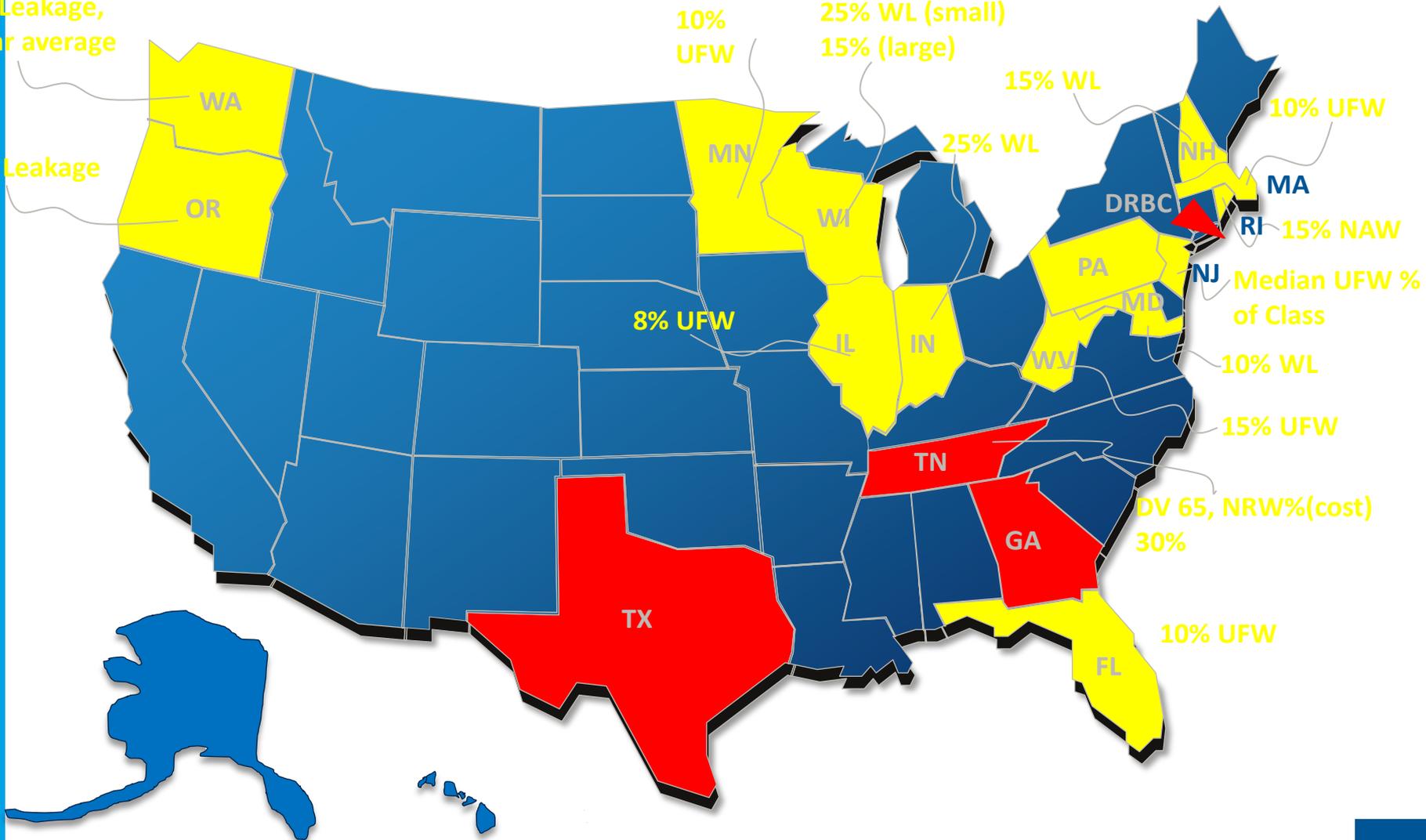
8% UFW

10% WL

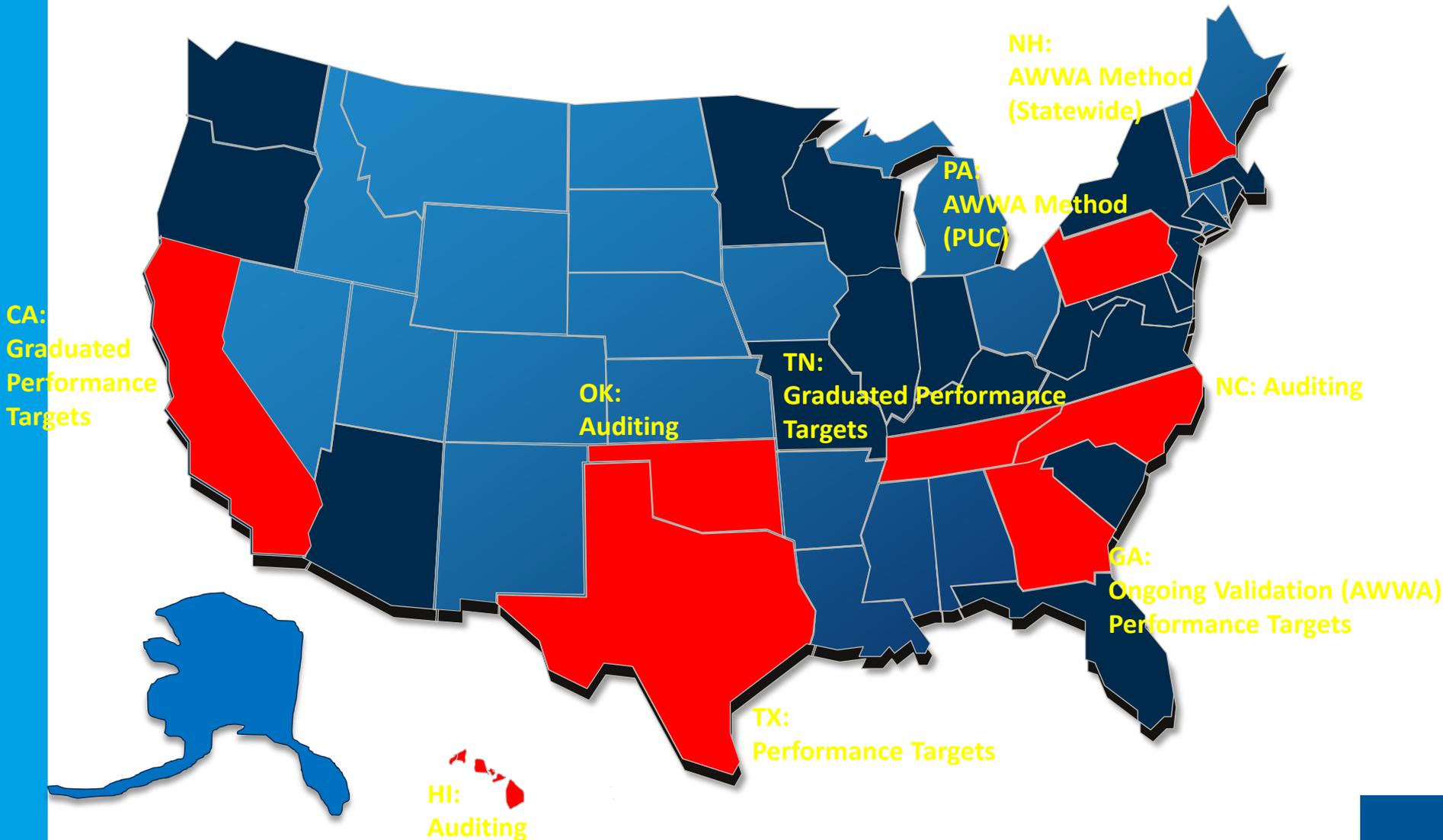
15% UFW

DV 65, NRW%(cost)
30%

10% UFW



A Look Ahead...



SUMMARY—WHY MANAGE NON-REVENUE WATER

- *The US drinking water industry is facing challenges of resource shortages, aging infrastructure, legal liability, public health and funding needs*
- *To address these, managing non-revenue water should become a standard business practice*
- *AWWA is actively promoting the IWA/AWWA Water Audit Method and providing tools for its use*
- *A number of state/regional agencies are already embracing these methods and applying them*



THE METHOD

SOFTWARE INSTRUCTIONS WORKSHEET

AWWA Water Loss Control Committee (WLCC) Free Water Audit Software v4.0

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WAS v4.0

PURPOSE: This spreadsheet-based water audit tool is designed to help quantify and track water losses associated with water distribution systems and identify areas for improved efficiency and cost recovery. It provides a "top-down" summary water audit format, and is not meant to take the place of a full-scale, comprehensive water audit format.

USE: The spreadsheet contains several separate worksheets. Sheets can be accessed using the tabs towards the bottom of the screen, or by clicking the buttons on the left below. Descriptions of each sheet are also given below.

THE FOLLOWING KEY APPLIES THROUGHOUT:

- Value can be entered by user
- Value calculated based on input data
- These cells contain recommended default values

Please begin by providing the following information, then proceed through each sheet in the workbook:

NAME OF CITY OR UTILITY: COUNTRY:

REPORTING YEAR: START DATE (MM/YYYY): END DATE (MM/YYYY):

NAME OF CONTACT PERSON: E-MAIL: TELEPHONE:
Ext.

PLEASE SELECT PREFERRED REPORTING UNITS FOR WATER VOLUME:

Click to advance to sheet...

Click here: for help about units and conversions

Instructions	The current sheet
Reporting Worksheet	Enter the required data on this worksheet to calculate the water balance
Water Balance	The values entered in the Reporting Worksheet are used to populate the water balance
Grading Matrix	Depending on the confidence of audit inputs, a grading is assigned to the audit score
Service Connections	Diagrams depicting possible customer service connection configurations
Definitions	Use this sheet to understand terms used in the audit process
Loss Control Planning	Use this sheet to interpret the results of the audit validity score and performance indicators

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COMMITTEES

YOUNG PROFESSIONALS

STUDENT CENTER

CANADIAN CONNECTION

DIVERSITY CENTER

AWARDS

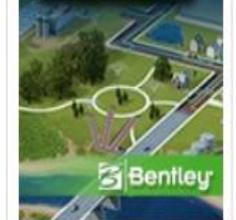
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▶ WATER LOSS CONTROL

DISCUSSION FORUM



Questions? Contact [AWWA's Water Loss Control Committee](#) directly.

Water Audit Software

The Water Audit Software includes a data-grading capability that allows the auditor to rate the overall degree of validity of their water audit data. Guidance on loss control planning is given based upon the credibility of the data and the measure of losses displayed by the water audit.

The Water Audit Software Compiler is a useful tool for managing the results from completed Water Audit Software files. Users can now compile all data into a master table and create charts showing audit components and basic histograms of grading values.

By downloading this software, you accept the Terms of Use below.

[English Terms of Use](#)

[French Terms of Use](#)

- [AWWA Water Loss Control Committee Free Water Audit Software v4.2 \(2010\) \(XLS\)](#)
- [AWWA Water Loss Control Committee Free Water Audit Software v4.2 French \(2010\) \(XLS\)](#)
- [AWWA Water Loss Control Committee Water Audit Software Compiler v4.2.9 \(2011\) \(XLS\)](#)

Hey Students

If you're pursuing a degree in this field, take a look at the wide range of scholarships available from AWWA and our partners.

[Full list of scholarships](#)

Water Loss Control basics

Utilities incur real losses from pipeline leakage and apparent losses when customer water consumption is not properly measured or billed. AWWA advocates the water audit method developed jointly by the International Water Association and AWWA. The IWA/AWWA Water Audit Method provides the best management practice tools and guidance water utilities need to efficiently manage their supplies.

- [IWA/AWWA Water Audit Method \(PDF\)](#)



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INITIAL VALIDATION

VALIDATING WATER LOSS DATA THROUGH THE WATER AUDIT DATA INITIATIVE

- **Data Initiative**

- Data Initiative started in 2010 with a small group (21 utilities) of utilities in North America
- The Utility needed to be willing to share their water audit data publically
- Using Software version 4.2 which was the first stable audit version with grading validation
 - Validation needed as first sets of data from Texas and California showed significant data variations and a large proportion (35 to 50%) of unusable data

VALIDATION METHODOLOGY

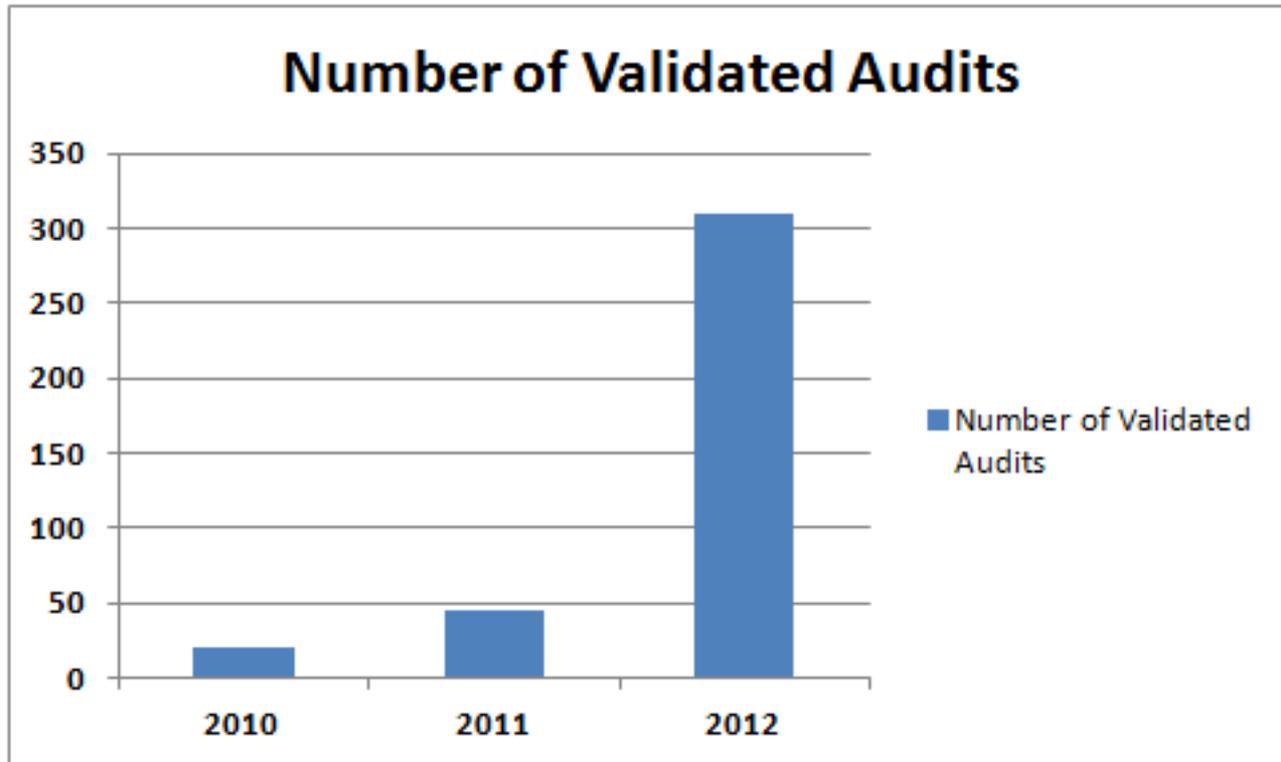
- **Primary Focus : “Validation” over “Outputs”**
 - Assuring valid data, rather than finding the system with the “lowest” losses
- **Validation process – standardized by the WLCC:**
 - A validation checklist of questions was developed to guide the validation telephone interviews
 - Conference call interviews conducted with utility representatives
 - Water audit inputs and gradings modified where deemed appropriate
 - Utilization of AWWA “Compiler” software developed for the management of water audit data from multiple utilities

AWWA WLCC WATER AUDIT VALIDATION PROCESS

- Standard set of questions
- Individual water system discussions about input and grading
- Uniform adherence to grading matrix definitions
- Consistent definitions and calculations

Form Source: AWWA Water Loss Control Committee EPD Large Systems 2011 Water Audit Validation 2011 Audit Validation Call Document					
Telephone Interview Date	EPD Team Member(s) Brian Skeens				
Water Utility Name:	Water Utility Interviewees	Water Audit Data Validity Score (from submitted data):	Infrastructure Leakage Index (from submitted data):		
Evaluation of Water Audit Components – entered quantities & data gradings					
Component	Submitted Quantity	Submitted Grading	Evaluation Comments	Final Quantity	Final Grading
Volume from Own Sources					
Master meter error adjustment					
Water Imported					
Water Exported					
Billed Metered					
Billed unmetered					
Unbilled metered					
Unbilled unmetered					
Unauthorized consumption					
Meter inaccuracy					
Handling errors					

PROGRAM PROGRESS (VALIDATED AUDITS)



VALIDATED DATA SUMMARY

Validated Data Summary (June 2013)

Key Performance Indicator	n	AVG
Data Validity Score	310	62.5
Non-Revenue Water as % by Cost	310	9.10%
Apparent Loss (gal/connection/day)	310	11.2
Real Loss (gal/connection/day)	248	56.5
Real Loss (gal/mile of main/day)	62	1,932
Infrastructure Leakage Index	283	3

WATER AUDIT – LARGE DATASET EVALUATIONS

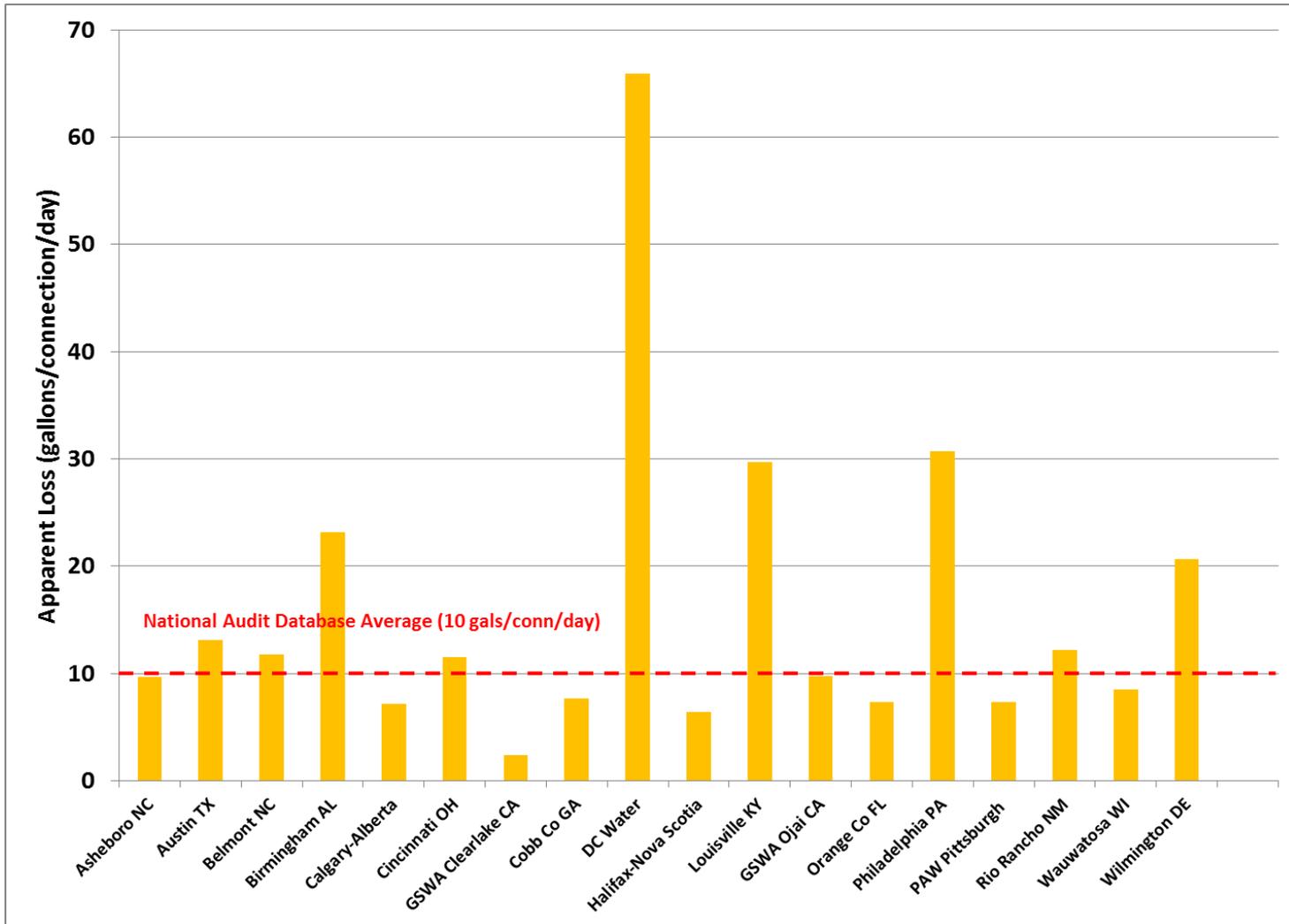
- In all the major dataset evaluations a large proportion of first analysis data is suspect.
 - In California and Texas up to 50% of first reports may be unusable
 - Significant extra effort is needed to educate the auditors
 - Time is required for this training to have an effect

NORTH AMERICAN WATER AUDIT DATA INITIATIVE SUMMARIES AND TRENDS

RECOGNIZED UTILITIES

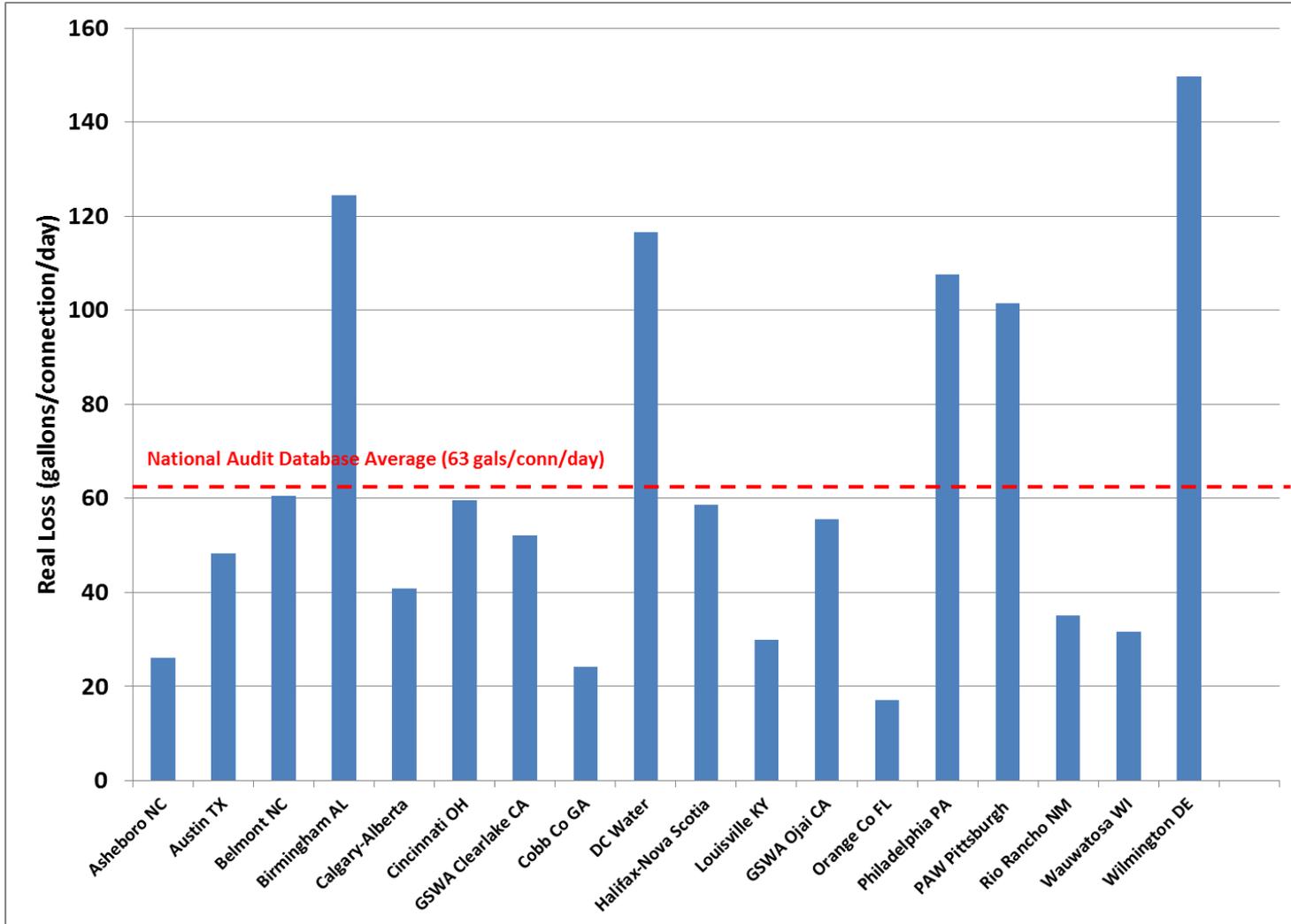
- **National Data from Recognized Utilities**
 - First set of data that puts a name to a dataset
 - Useful in benchmarking against similar utilities (size, location, losses...)
 - Useful in helping determine a value for difficult to determine inputs and to make sure data is within a reasonable range
- **Standard Process and Documentation**

BENCHMARK WATER LOSSES



2012 Dataset – Real and Apparent Loss per connection

BENCHMARK WATER LOSSES



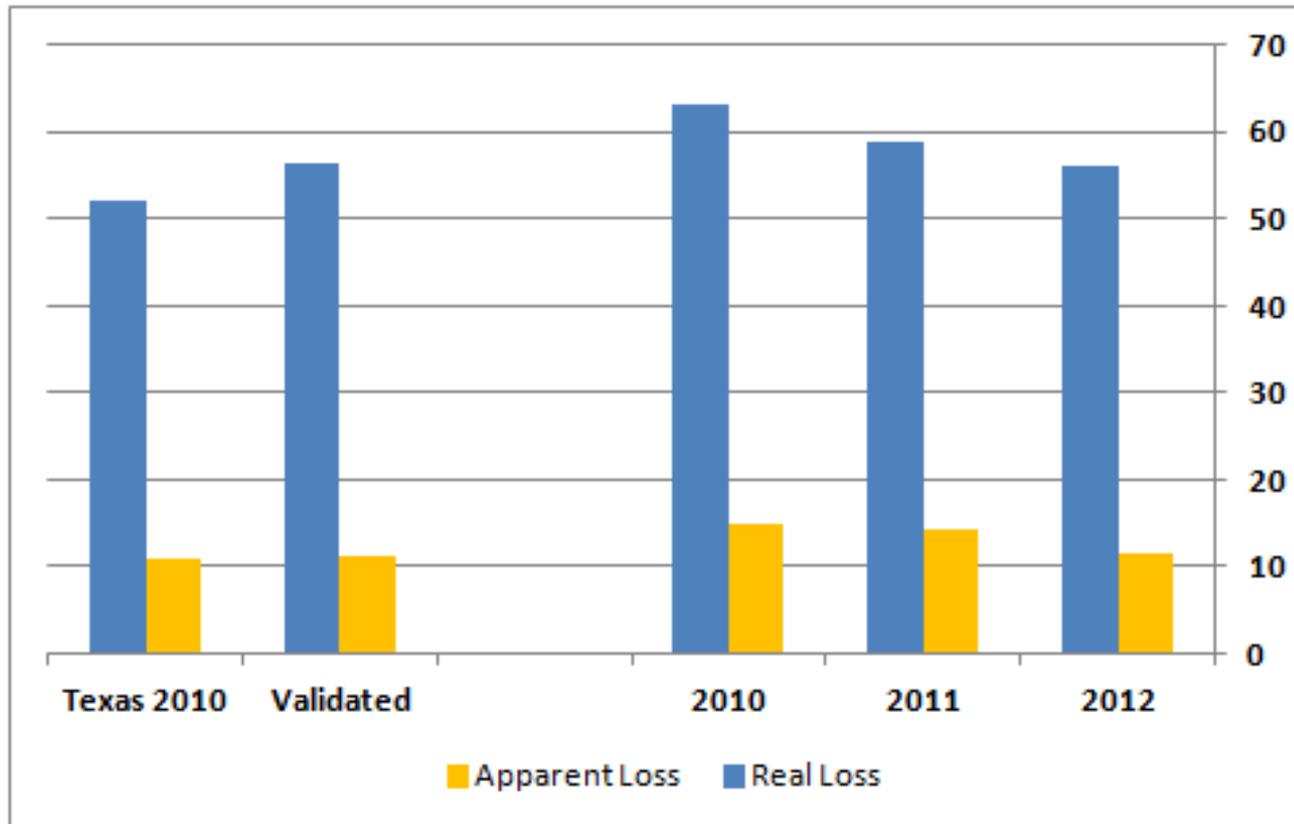
2012 Dataset – Real and Apparent Loss per connection

EMERGING TRENDS

NATIONAL DATASET

- **Utilities Involved**
 - Between 21 and 26 utilities for the last three years
 - 15 Utilities have been with the data initiative since all three years
- **Trending**
 - Currently the National dataset is the only actively validated water audit dataset with a three year history

REAL AND APPARENT LOSS TRENDS



NATIONAL DATA INITIATIVE

ACKNOWLEDGEMENTS

Water Audit Software Subcommittee (WASS) Members:
WLCC Chair: John Van Arsdel, M.E. Simpson Company, Inc.
WASS Chair: Andrew Chastain-Howley, Black & Veatch
George Kunkel, Philadelphia Water Department
Will Jernigan, Cavanaugh & Associates, P.A.
Alain Lalonde, Veritec Consulting Inc.
Ralph McCord, Louisville Water Company
David Sayers, Delaware River Basin Commission
Brian Skeens, CH2M HILL
Isabel Szendry, Puerto Rico ASA